GSOE9210 Engineering Decisions

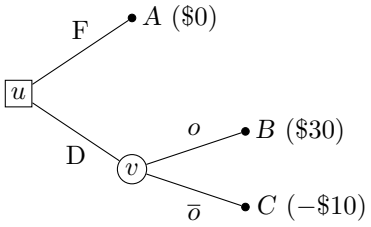
Problem Set 01

1. The hypothetical scenario below is one that you may well find yourself in:

   > You're the founder of a start-up which is developing a new technology which could be worth upwards of $100M. Your patent is due to expire at the end of your year, as is your funding. You're currently developing your 5th, and last, major prototype before your patent expires. Each previous prototype has failed. You're hoping that the changes you've made in this one will work, but you are worried that the problem cannot be fixed with your existing resources.
   >
   > Last week a major international corporation approached you and offered to buy the rights for your technology for $10M. You will have to respond to the offer before you know the outcome of the current prototype.

   Formulate this problem as a decision tree and/or table. To help you become comfortable using the forum, and start off the process of working collaboratively, please post your solution, or your comparison with someone else's solution, on this week's forum. You might take a picture/screenshot of your solution and share it.

2. The decision tree of the oil drilling example discussed in lectures is shown below. Values are in units of millions.



   (a) What type of node is u? v? B?
   (b) The root node of this tree is of what type?
   (c) Suppose that the dollar values given don't include the additional cost of extracting oil. If the extraction cost is $5, how should the tree be modified?

   Solution:

   (a) u is a decision node; v is a chance node.
   (b) The root node (u) is a decision node.

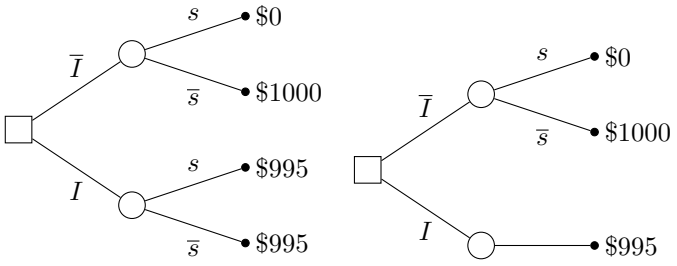
(c) The outcome B (drill and find oil) would be reduced by \$5 to \$25.

3. For the problems below, discussed in lectures, draw decision trees and decision tables.

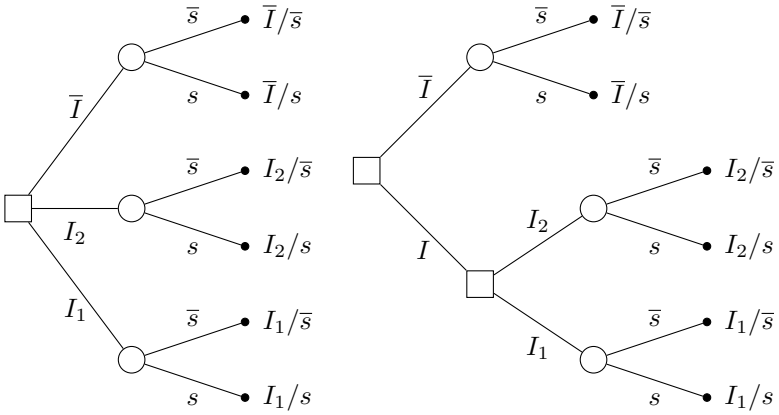
   (a) The necklace insurance problem.
   Assume that the value of the necklace is \$1000 and the annual cost of insurance is \$5, and that insurance will reimburse the buyer for the full value of the necklace.
   (b) The football club inventory problem.

   How would you modify the representations above if Alice had two insurance policies to choose from?

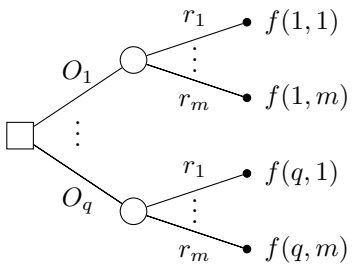
   Solution: For the basic insurance problem:



   Possible trees for the two insurance policy problem are shown below:



   A possible decision tree for the football club problem is shown below:



where

$$f(q,m) = \begin{cases} 40m - (500 + 20q) & \text{if } q \geqslant m \\ 20m - 800 & \text{if } q < m \end{cases}$$

For the case where $q < m$ (the membership exceeds the initial order), the second order will be for the excess (*i.e.*, $m - q$ uniforms), bringing the total order to m uniforms. Because the club makes a profit of \$20 on each uniform and there are m uniforms ordered in total (to cover the membership), the profit is $\$20m$ minus the fees for placing both orders (*viz.* \$500 + \$300 = \$800).

4. *Sam's dining problem*

Sam is about to order a two-course meal at a restaurant. He has the following course choices: for the main course he can order either pasta or a salad. After the main course, he will be given the choice of either desert or coffee.

Initially he is unsure as to whether or not either of the first course options will leave him feeling full.

For this decision problem identify:

(a) the actions
(b) the possible states

The menu prices are:

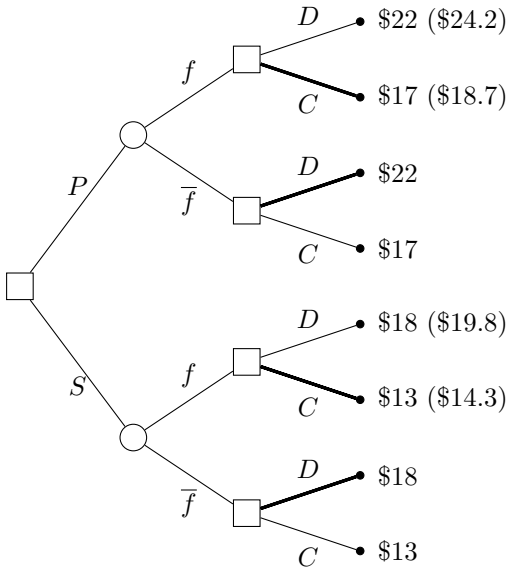
Mains	Price	Deserts	Price
pasta	\$14	desert	\$8
salad	\$10	coffee	\$3

Once you've decided on the actions and states, draw a decision tree in which the outcomes are measured by the total cost of the meal.

Solution:

(a) Primitive actions: order Pasta (P); order Salad (S); order Desert (D); order Coffee (C).
(b) Possible states: full after main course (f); not full ($\overline{f}$).

The tree might look as follows:



5. Modify the decision tree for the dining problem above for the case where Sam gives a 10% tip if the main course is filling.

   Solution: See the parenthesised values in the earlier tree.

6. Suppose that finishing with desert always leaves Sam feeling full. If Sam wants to ensure that he finishes his meal feeling full but wants to minimise the cost of the meal, what should be Sam's 'policy'?

   Hint: A policy must guarantee a unique outcome given a state. Informally, a policy for this problem might look like something like: "Choose X first; if y happens, then choose Z."

   Solution: Sam's policy to guarantee finishing full for the lowest price:

   > choose salad; if the main is filling then choose coffee; if the main is not filling then choose desert.

7.* Draw a decision table for Sam's dining problem.

   Hint: A decision table must represent a function mapping each pair consisting of an action and a state to a *unique* outcome.

8. For the software project budgeting example in lectures, how would the decision be affected if the discount rate was 10%?

   Solution: With a *discount rate* for each period of 10%:

$$\begin{aligned} NPV(\text{A}) &= -10 + \frac{5}{1.1} + \frac{25}{1.1^2} &&= 15.2 \\ NPV(\text{B}) & &&= 13.0 \\ NPV(\text{C}) &= -5 + \frac{10}{1.1} + \frac{12}{1.1^2} &&= 14.0 \end{aligned}$$

In this case, project A would be most preferred and B would become least favourable.

9. Describe a decision problem of you've had recently; it could be something as simple as deciding which route to drive to work. Formulate it in terms of actions, possible states, outcomes, and their values, and represent it as a decision tree or table. Post a description of the problem on the forum (Exercises Week 1) together with your solution (*e.g.*, a photo of a drawing on paper of your decision tree/table), or comment on a problem posted by someone else which is similar to yours.